REVISED NO_X BACT:
Selective Non-Catalytic Reduction (SNCR) has not been identified as a NO_X control technology currently installed on a source similar to the proposed coal-fired calciners. However, SNCR vendors were contacted and they believe it is a feasible technology for our calciner furnace conditions. SNCR is a post-combustion process that reduces NO_X (NO and NO_2) by the reaction with ammonia (NH_3) to form nitrogen (N_2) and water per the following formulas:

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6\ H_2O$$

$$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6\ H_2O$$

Since urea is not poisonous and easier to handle than ammonia, it is often used as a precursor to ammonia per the following formula:

$$CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2$$

The three key parameters that affect the reaction of ammonia with NO_X are flue gas temperature, reagent distribution, and CO concentration. The temperature exiting our furnace is between 1700ºF and 1800ºF, which is in the optimal temperature range for the reaction. A computational fluid dynamics (CFD) model can be run to locate the appropriate reagent injection sites and droplet size distribution, taking into account temperature and gas velocity.

The reaction of ammonia with NO_X is also affected by the concentration of CO in the furnace. The CO concentration in the furnace due to combustion only, is estimated to be 25 ppm. As reported in the March 6, 2003 submittal of this permit application, the CO concentration was estimated to be 522 ppm with Flue Gas Recirculation (FGR). That estimate did not account for the CO emissions associated with the calcination of trona ore, which would be recirculated as well. The May 4, 2000 stack testing of CA-1&2 (AQD #17) resulted in one-minute average CO concentrations ranging from a low of 465 ppm at 11:01 a.m. to a high of 1,772 ppm less than two hours later, at 12:52 p.m. The variation of CO emissions from the trona ore is not fully understood. The CO concentrations change with no apparent variation in ore quality or calciner operating conditions. Since the May 4, 2000 stack testing was only three one-hour runs, Solvay believes the CO concentration in the calciner off gas could rise over the 1,772 ppm that was monitored that day.

Fuel Tech, a leader in post-combustion NO_X controls, estimated the NO_X reduction efficiency of SNCR at various furnace CO concentrations as detailed in the table below:

CO (ppm)	Base NO_X rate (lb/MMBtu)	Controlled NO_X rate (lb/MMBtu)	NO_X reduction (percent)
25	0.79	0.43	46
500	0.45	0.29	36
1000	0.45	0.33	27
1500	0.45	0.43	4

As noted in the table, the performance of SNCR is affected by the CO concentration. The highest NO_X reduction calculated is 46%, which is at the lowest concentration of CO at 25ppm. The lowest NO_X reduction calculated is 4%, which is at the highest CO concentration considered, 1500 ppm. If flue gas was recirculated from the furnace only, not the calciner exhaust, the approximate 500 ppm CO would result in an SNCR efficiency of 35%. However, since the function of FGR is to reduce thermal NO_X through the lowering of the flame temperature and minimized O_2 concentrations, the flue gas temperature from the furnace of 1800ºF would not effectively reduce the flame temperature for NO_X reduction like the 300ºF to 500ºF off-gas from the ESP after the calciner. Furthermore, the "product" sent from the furnace to the calciner is hot air to calcine the trona ore. Recirculating the off-gas from the furnace before going through the calciner defeats the purpose of heating the air for calcination of the trona ore.

Following is a summary table of the cost effectiveness of FGR, Water Injection (WI), and SNCR, per calciner. The Total Annualized Costs are detailed in the attached spreadsheets.

Control Technology	Total Annualized Cost	Base TPY NO_X	TPY NO_X removed	NO_X removal (%)	\$/ton NO_X removed
SNCR + FGR + WI	783,000	692	315	46	2,486
SNCR	624,000	692	315	46	1,981
FGR + WI	273,000	692	298	43	916
FGR	187,000	692	238	34	785
WI	87,000	692	60	9	1,461

Note that the annualized cost of SNCR + FGR + WI is \$783,000, which is not the same as the sum of the three controls separately of \$898,000. This is due to less reagent usage if all three controls were installed.

The following table summarized incremental costs:

Case #1	Case #2	Additional NO_X removed (TPY)	Additional annual cost ($)	Incremental cost ($/ton)
SNCR	SNCR + FGR + WI	0	159,000	N/A
FGR + WI	SNCR	17	351,000	20,647
FGR	FGR + WI	60	86,000	1,433
WI	WI + FGR	238	186,000	782

Two control scenarios, SNCR alone, and SNCR + FGR + WI result in the same NO_X reduction of 46%, or 315 tpy. This is due to the reduced effectiveness of SNCR in the presence of increased levels of CO due to FGR. The incremental cost to control the 17 additional tpy of NO_X that SNCR achieves beyond what FGR + WI achieves, is $20,647. This amount is economically unreasonable.

The incremental cost to control the 60 additional tpy of NO_X that FGR + WI achieve beyond what FGR alone achieves, is $1,433. The incremental cost to control the 238 additional tpy of NO_X that FGR + WI achieve beyond what WI alone achieves, is $782. These two incremental costs are economically reasonable.

In summary, FGR with WI is considered BACT for controlling NO_X on the proposed AQD #17 (A&B Calciners).